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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 80.

THE PEACH TWIG-BORER:

AN IMPORTANT ENEMY OF STONE FRUITS.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., June 15, 1898.

SIR: I have the honor to transmit herewith a Farmers' Bulletin on the peach twig-borer, an important enemy of stone fruits. It has been prepared by my first assistant, Mr. C. L. Marlatt, and consists in the main of a revision of an article published in Bulletin No. 10, new series, of this Division. It is issued in its present form to supply a demand for a larger circulation of the information contained in the article cited, particularly in California and elsewhere on the Pacific slope, where the twig-borer is especially abundant and destructive.

Respectfully,

L. O. HOWARD, *Entomologist.*

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE PEACH TWIG-BORER.

(*Anarsia lineatella* Zell.)

INTRODUCTION.

This insect is of European origin, but has been known to occur in the United States since 1860. It has been very injurious at times to peach trees in the peach-growing sections of the East, notably in Maryland, Delaware, and Virginia, also in New Jersey and New York, and more recently in West Virginia. In California and Oregon, and elsewhere on the Pacific slope, its injuries have taken a wider range, including damage to the apricot, almond, nectarine, prune, pear, and perhaps other fruit trees in addition to the peach.

In California it is listed as one of the three or four worst insect pests occurring in the State. In Washington as many as one hundred larvæ, or instances of damage to as many twigs, have been counted on a single tree. In Oregon this insect is stated to be next to the peach-tree borer in the amount of damage it occasions, particularly in the Willamette Valley. In western Colorado it is very destructive to peach, plum, apricot, and almond.

The injury occasioned by this insect is limited almost exclusively to the work of the hibernating larvæ during the latter part of April and first of May, when they bore into the shoots of new leaves, killing the growing terminals and preventing the development of the branch, although sometimes a whorl of living leaves may remain at the base. Much of the new growth of the tree is often killed, in many instances the branches remaining with scarcely a bud or shoot which has not been thus destroyed. This necessarily results in greatly checking the vigor and fruiting capacity of the tree, and causes an irregular and knotty growth.

The summer broods of larvæ feed beneath the bark or in the fruit stems, occasionally, when nearly full grown, boring into the fruit; but such damage is not ordinarily noticed and is slight as compared with the injury occasioned by the first or hibernating brood of larvæ.

RECENT STUDIES OF THE INSECT.

Up to comparatively recent years the knowledge of this insect has been practically confined to its injury to peach twigs, either in terminals before the trees leaf out in the spring, a rare form of attack, or in the

young shoots—the usual and destructive habit—and later and more rarely in the ripening fruit. In connection with these descriptions of damage are also accounts of what was then believed to be the same insect affecting the strawberry, one brood wintering in the half-grown larval stage in the crown of the plant, and a second brood working during early summer in the young shoots and runners.

The confusion of these two distinct species, attacking widely dissimilar plants, continued until 1897, and still obtains to a great extent. There necessarily resulted a thorough misapprehension of the habits of the twig-borer and the suggestion of needless precautionary measures, such as the abandonment of the culture of the strawberry, at least in proximity to peach orchards.

In 1893 some very interesting observations were made by Mr. Ehrhorn, in Santa Clara County, Cal., and reported by Mr. Craw, demonstrating that the twig-borer winters, in the larval stage, not in the crown of the strawberry plant, as had been previously thought, but in peculiar chambers situated for the most part in the crotches of the branches of the trees attacked, the larvæ leaving these chambers in the spring to do the notable damage characteristic of the species.

While passing through California in the fall of 1896, the writer examined, in company with Mr. Ehrhorn, the curious hibernating chambers made by the newly-hatched larvæ, and the habits of this insect, as far as then known to Mr. Ehrhorn, and substantially as had been already recorded by Mr. Craw, were explained to him. The discovery of this peculiar hibernating habit of *Anarsia lineatella* is very interesting in itself, and is also a long step toward the completion of our knowledge of the life history of the insect, and is especially valuable as suggesting better means than any heretofore known of preventing damage from it.

Arrangements were made with Mr. Ehrhorn at the time to supply the Department with ample material of the young larvæ in their hibernating cells; and, throughout the winter, spring, and early summer of 1896-97, material was repeatedly sent for study to Washington, D. C.

Some of the twigs containing the young hibernating larvæ were during the winter fastened to peach trees growing in the entomological nursery attached to the insectary. Most of the larvæ in these twigs had been killed by a predaceous mite, and some few, perhaps, died as a consequence of the drying up of the twigs, but a considerable number of them wintered safely and ultimately entered the new shoots in the early spring and completed their development. With this material we were enabled to study their habits out of doors under natural conditions, following the species carefully through two generations and into the commencement of a third, as will be detailed below. By the end of August our working stock died out and we were unable to secure fresh supplies. The studies made in Washington were supplemented and confirmed by the field observation of Mr. Ehrhorn covering the same period and continuing until the hibernating cells reappeared in the crotches in August and September.

About the same time Mr. A. B. Cordley, entomologist of the Oregon Experiment Station, was also investigating the habits of this insect, his account comprising a description of the injury to peach and prune twigs in early summer, and the work of similar larvæ in strawberry beds in October, the latter larvæ wintering in the crowns of the plants.

HISTORY AND DISTRIBUTION.

The peach twig-borer is apparently an Old World species and probably a very ancient enemy of the peach, with little doubt coming with this fruit from western Asia. It was described in Europe in 1839, and in this country in 1860. The American species was afterwards shown to be identical with the European peach moth. As an important injurious insect in this country, attention was first drawn to it about 1872 by Mr. Glover, a former entomologist of the Department, and also by Mr. Saunders, of Ottawa, the report of Mr. Glover being the first published. Glover's report describes excessive damage by it as a twig-borer in young peach orchards in Maryland, and Saunders's report, while relating chiefly to marked injury by a crown-borer in strawberry beds (now known to be a different insect), refers also to injury to the peach twigs in Ontario. Some years later, Prof. J. H. Comstock, while entomologist of the Department, reported considerable damage from the peach twig-borer in Virginia and in the District of Columbia, and first noted the peculiar fruit-inhabiting brood. Later the insect was made the subject of an article by Dr. J. A. Lintner, in which it is reported to have occasioned damage to peaches in several localities in the State of New York. We also have accounts by Prof. C. V. Riley, of injury to strawberry plants in Illinois, referred by him to *Anarsia lineatella*, and also articles on this insect, particularly as a strawberry miner, by Prof. S. A. Forbes. Very great damage to peaches in Kent and Sussex counties, Del., was reported later by Riley and Howard.

On the Pacific slope record was made of injury by it to various stone fruits by Mr. Coquillett, and later similar damage was reported from Vancouver. We have also the results of the investigations by Mr. Ehrhorn in California, and the recently published accounts by Mr. Cordley relative to the insect as affecting peaches and prunes in Oregon, and also in strawberry beds—a similar but undoubtedly distinct insect.

That this twig-borer is very destructive to the peach, plum, apricot, and almond in western Colorado is shown by recent accounts, and damage from it has also been lately reported in West Virginia.

In addition to the more important published accounts, injury from the twig-borer has been often recognized and reported by various observers in recent years. Nearly all these reports refer to the injury to twigs of stone fruits, and very few to the strawberry, the allied insect which infests the latter either being more rare or less often observed. The records of this Department show the presence of the twig-borer in at least twelve States, and give it a range which indicates that it is practi-

cally as wide-spread in this country as is the culture of its principal food plant.

If not already cosmopolitan in distribution, the peach twig-borer is rapidly becoming so, and will probably follow the peach and other stone fruits wherever they are cultivated, especially as its peculiar hibernating habit greatly facilitates its distribution with nursery stock.

LIFE HISTORY AND HABITS.

The fall brood of larvæ discovered by Mr. Ehrhorn may be taken as a convenient starting point in the life history of the peach twig-borer. In the fall, according to Mr. Ehrhorn, they appear as very small larvæ, living and working in the spongy bark chiefly at the crotches of the branches of the peach, and he surmises that they are from eggs deposited in these situations. Here the larvæ are supposed to grow

slowly until the new growth appears in the spring, when they leave their cells in the bark and enter the new shoots. It is stated, also, that frequently the larvæ are nearly full grown when they attack the young growth. A later brood is said to attack the fruit near the stems. The occurrence of the larvæ during the winter in the situations described is also thought to explain the fact frequently noted that the under and inside twigs, being the more accessible, suffer the most, while the exterior and topmost branches escape.

Later studies confirm, in the main, Mr. Ehrhorn's conclusions as to

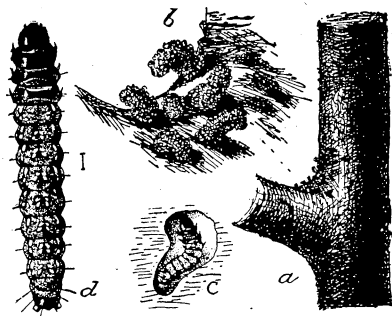


FIG. 1.—*Anarsia lineatella*: *a*, twig of peach, showing in crotch minute masses of chewed bark above larval chambers; *b*, latter much enlarged; *c*, a larval cell, with contained larva, much enlarged; *d*, dorsal view of young larva, more enlarged (original).

the habits of the larvæ. That the larvæ make any essential growth in the winter, however, is probably a wrong inference, as will be shown later, and the nearly full-grown larvæ referred to were doubtless individuals that were wandering from one point to another, and had merely reached nearly full growth before they were observed.

Both in the orchards of California and by means of the abundant material received at this office we have been enabled to make a careful study of the hibernating galleries, or chambers, of the young larvæ. These occur not only in the crotches of the smaller and sometimes quite large branches, but many of the larvæ utilize the roughened bark at any point. They burrow into the bark for a short distance, penetrating little more than the upper superficial layer, and form slightly elongated chambers (fig. 1, *c*), which are lined with white silk and the opening afterwards closed. The location of the larvæ may be readily recognized by the little masses of projecting excrement or comminuted bark at the entrances to the burrows (fig. 1, *a*, *b*). The size of the burrow and

the fact of its being lined with silk precludes the idea that the larva feeds in the fall or during hibernation, except perhaps in the mere operation of excavating the chamber.

The young larva, as taken from the burrow, is not above 2 millimeters long, and is of a general yellow color, with the head and cervical and anal plates dark brown, almost black (fig. 1, *d*).

While in their winter quarters the larvæ are subject to the attacks of predaceous mites, and many of them are destroyed by this means, as will be later noted. They are also occasionally parasitized by a chalcidid fly.

Early in April the larvæ begin to abandon their hibernating quarters and attack the new leaf shoots, but some individuals were found in the crotches by Mr. Ehrhorn as late as April 21. The damage becomes noticeable, as a rule, at the time the shoots are from one-half inch to 2 inches in length, or, more properly speaking, mere clusters of newly expanded leaves.

Glover's account of their working downward in the old twigs from the terminal buds before the starting of the leaves in April apparently can not be questioned, but seems not to be the normal course, as shown by the observations since made.

In our experience, the larvæ begin to migrate only after the new foliage has begun to put out, and they attack the new shoots at any point, generally, however, from one-half inch to an inch from the apex, either near or in the crotch formed by the leaf petiole and the stem. The longest burrow observed was $1\frac{1}{2}$ inches and the shortest one-fourth inch. Sometimes the burrow extends about one-eighth inch above the entrance, and occasionally the larvæ simply eat into the shoot as far as the pith and then go elsewhere. The larvæ are seemingly restless and not easily satisfied, and are continually moving from one shoot to another, and are most active travelers. In this way a single larva may destroy or injure several shoots before reaching maturity, thus greatly increasing the damage.

Professor Comstock's observations on the habits of the larvæ in the young shoots are slightly at variance with the above. He says the larvæ puncture the shoots at the base, eating them off completely, the severed twigs remaining attached to the branch by the gummy substance which exudes from the wound. This particular form of injury we have not noted.

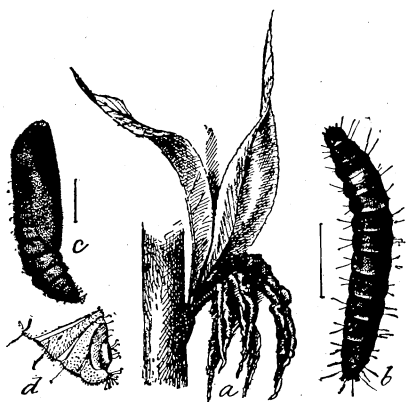


FIG. 2.—*Anarsia lineatella*: *a*, new shoot of peach withering from attack of larva; *b*, larva enlarged; *c*, pupa enlarged; *d*, tip of pupa more enlarged (original).

When working in the succulent new growth the larvæ bores rather rapidly, sufficiently so at least to excavate a burrow two-thirds of its length in an hour. The length of time spent by the hibernated larvæ in coming to full growth in the green shoots is comparatively short, not exceeding ten to fifteen days.

In California, and also in the District of Columbia, the larvæ begin transforming to pupæ in the latter part of April, and the moths of the first brood emerge throughout May. In Colorado, Mr. Gillette has bred the moths the first of June and also toward the end of July. In Oregon, Mr. Cordley secured his first pupa on May 8 and his first moth on May 17.

The adult larva tapers strongly toward either end, and attains a length of three eighths to a half an inch, or slightly more when in motion. It is of a dull reddish-brown color, the reddish color predominating before maturity and the latter after maturity, and the head and the cervical and anal shields are dark brown or almost black. The space between the segments is noticeably light-colored, and especially between the second and third thoracic segments. The hairs are long and spring singly from minute tubercles. Other details of structural features are shown in the illustration (fig. 2, *b*).

In confinement the larva on reaching full growth spins a scanty web, in no sense a close cocoon, in the leaves and rubbish about the trees, or on the trees in the dried and shriveled leaves of the injured shoots, or it attaches itself exposed on the twigs or bark. After thus securing itself the larva immediately pupates, becoming a brown, rather robust, chrysalis (fig. 2, *c, d*). In midsummer these transformations are very quickly accomplished. A larva, for example, which webbed up June 29, pupated July 1, and the adult emerged July 8.

Mr. Ehrhorn states that it is very difficult to find the pupæ in orchards, as the larvæ hide in all sorts of places, as in crotches of the branches, between dried leaves, and about small peaches likely to drop off.

The chrysalis stage lasts from seven to ten days, and the moths of the first brood begin to appear early in May and continue to emerge throughout this month and into June in the latitude of Washington.

The adult moth is less than a quarter of an inch in length, expanding a little more than half an inch, and is of a beautiful dark-gray color, with darker spots on the forewings, as indicated in the illustration (fig. 3). It is a handsome insect, and has a peculiar way of resting with its palpi bent back over its head and its antennæ laid closely down on the wings.

The actions of the moths out of doors have been recently described by Mr. Cordley. During the daytime they remain perfectly still on the bark of the tree, and with the forepart of the body slightly raised and the labial palpi held rigidly upright in front of the face. They so closely resemble small, rough projections of the bark that it is almost impossible to distinguish them. When disturbed they dart rapidly about for an instant and then as suddenly alight in a new position.

The egg-laying habits of this insect previous to 1897 having been merely a matter of conjecture, special effort was made to get the facts concerning this feature of the life history. A number of moths reared in the insectary were confined about May 10 with peach twigs 8 to 10 inches in length, of this year's growth. The examination of the material was unfortunately too long delayed, but on May 28 it was found that many eggs had been deposited on these peach twigs, an egg having been placed apparently just above the base of the petiole of nearly every leaf. When examined, most of the eggs had hatched and the larvæ had entered the twigs at or near the crotch formed by the leaf and twig, the point of entrance being indicated by a little mass of brown excrement.

The egg had evidently been placed in the protection formed by the two little spurs at the base of the petiole. Subsequently many other eggs were obtained from other moths, and they were, for the most part, similarly situated, namely, around the base of the leaves. In one instance nine eggs were deposited around the base of a single leaf, six of them close together under one of the bracts at the base of the petiole and three in the depression or scar left by the second bract, which had dropped.

The recently deposited eggs are white in color and iridescent, but before hatching become distinctly orange. They measure about four-tenths of a millimeter in length by two-tenths of a millimeter in breadth, are somewhat ovoid, and are lightly attached lengthwise to the twig by a glue-like material. Under a high power they are seen to be coarsely and rather regularly reticulated, as shown in the illustration (fig. 4, a).

In confinement the moths live about ten days, and most of the egg-laying is in the first half of this period. The habits above described are those of caged moths, but it is reasonable to suppose that in a state of nature the eggs are deposited in much the same way, and this is rendered almost cer-

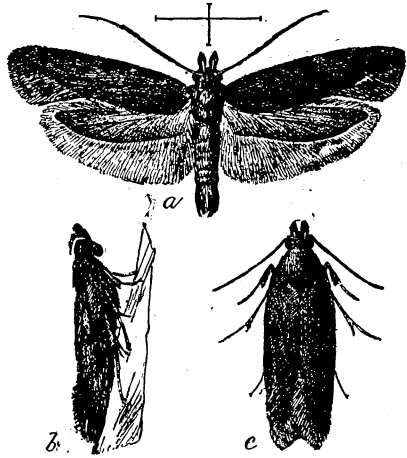


FIG. 3.—*Anarsia lineatella*: a, moth with spread wings; b and c, same with wings closed, illustrating position normally assumed—all much enlarged (original).

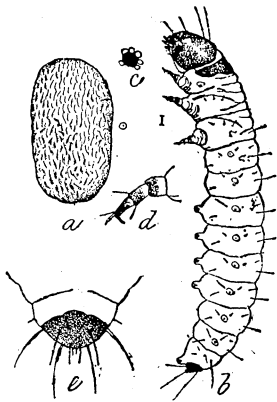


FIG. 4.—*Anarsia lineatella*: a, egg; b, young larva; c, eye; d, thoracic leg of larva; e, anal segment from above—all greatly enlarged (original).

tain by the great regularity noted in the manner of their deposition. In but one or two instances were the eggs placed in other situations—one being placed on the upper surface of a leaf close to the midrib, and two together placed in a groove at the side of the base of the leaf.

From eggs deposited later than those first mentioned, viz, about June 3, larvæ appeared June 15, indicating a period of about twelve days between the laying of the egg and its hatching.

The newly hatched larvæ measure about 1 millimeter in length and are of a very pale yellow color, with the head and cervical and anal plates black and the thoracic legs dusky. When first noted they had excavated channels somewhat longer than themselves and about twice as broad into the twigs, the entrance being marked by a small mass of excrement. By June 3 most of the older larvæ had abandoned their original burrows and were constructing new ones in similar situations on fresh branches of the peach, with which they were from time to time supplied. This they continued to do, viz, to construct new burrows every few days until they were full grown. On June 23, of the three remaining individuals of this lot of larvæ, one had already pupated in a folded leaf and the other two were fully grown and about ready to transform, which they both did before the end of the month.

About the end of June some peaches were received from Mr. Ehrhorn, said to be infested with the second brood of larvæ. Some of the peaches had been bored into a little way near the stem by what was evidently, from the size and nature of the burrows, nearly full-grown larvæ of the second brood. One of these was found, and also one pupa. On further examination, however, it was discovered that the larvæ of what is undoubtedly the third brood (the second of the summer broods) were present in numbers, not in the fruit, but in the short stems of the fruit, which at this season are green and somewhat succulent. In these stems they had made their little chambers not unlike those in the twigs above described or those in the crotches in the fall, except that they were for feeding purposes and not lined with silk, as are the latter. Others were also found at the base of the leaf stalks, just as we had been finding them in our breeding cages.

We were unable to carry our breeding-cage material farther than this point at Washington, D. C., and Mr. Ehrhorn was unable to furnish additional supplies, but he writes that he found the minute larvæ in the crotches of the trees as early as August 21. It would seem from this last and very important observation that some, at least, of the fourth brood of larvæ, if not all of them, go into winter quarters, and at a period much earlier than would have been supposed.

These facts go a long way toward clearing up the life history of this insect, and indicate a much more uniform habit in the different broods than has hitherto been supposed.

The old idea that this insect is double-brooded, the first brood living in the twigs and the second brood affecting the ripening fruit, must be

abandoned. At the time of the appearance of the first brood of moths during the month of May the fruit of the peach is of considerable size, especially by the end of the month, but is green, hard, and densely hairy, and is probably rarely if ever chosen by the parent moths as a nidus for her eggs. The normal location of the eggs and the point at which larval development begins is indicated by the foregoing notes, and there is no reason to doubt but that at all seasons of the year larvæ develop in the new growth, entering normally at the axils of the leaves or in the stems of the green fruit. In these situations the eggs are placed and the young larvæ construct their little oval chambers, which they abandon from time to time to make new ones, rarely doing enough damage in the later broods at any one point to be noticeable. As they attain larger size they travel more and often bore into fruit near the stem, where the greater exudation of gum and more serious character of the injury draw attention to them. In the case of the burrows in the twigs the more abundant new growth and more mature condition of the wood render the injury much less noticeable, nor are the results of the attacks so marked as in the injury to the new growth in April.

Our records for the first summer brood indicate a period of about six weeks as necessary for its complete development. The time necessary in the warmer months for the later broods is probably even less, and it is evident that there are certainly three broods of larvæ annually, if not four.

One of the important points remaining to be cleared up in regard to this insect is whether the larvæ found in the crotches of the branches in late summer and fall come from eggs placed in these situations or are migrants from some other parts of the plant. Mr. Ehrhorn's supposition that the eggs were placed by the moth where the larval chambers are afterwards found is borne out by the small size of the larvæ, which are not much larger than when newly hatched. The comparatively large size of the egg, and its striking appearance, and the lack of any attempt at concealment of it should enable one, where the insect is abundant, to clear up this uncertain feature without difficulty.

THE STRAWBERRY CROWN-MINER A DISTINCT INSECT.

The generally held belief hitherto that the lepidopterous crown-miner of the strawberry is the same insect as the twig-borer of the peach will have to be abandoned. If there were no other evidence on which to base this conclusion, the habits of the twig-borer, as now known, throughout the year are so peculiar and distinctive as to render very improbable the supposed strawberry infesting habit.

That we have two distinct insects is also convincingly shown by a comparative study of the larvæ from the strawberry and from the twigs of stone fruits, obtained from various parts of the country, made in connection with an examination of the published descriptions of larvæ and their habits from both sources. So dissimilar are the larvæ

that there is no basis whatever for connecting them with the same insect, and in fact they probably belong to different families.

The moths of the strawberry crown-miner, on the other hand, are very similar in appearance to the moths of the twig-borer, as dry, mounted objects. The habits of the living insects, however, of the two species are, on the authority of Mr. Cordley, very dissimilar. The twig-borer moths are slightly larger and darker colored than the strawberry insect, and invariably take an elevated position in the breeding cage with the fore part of the body slightly raised and the labial palpi held rigidly upright in front of the face, as elsewhere noted. The moths reared from the strawberry crowns, on the other hand, crawl down among the vines, even into crevices in the soil, apparently for the purpose of depositing eggs upon the crowns of the plants, and when disturbed run or flutter about with wings half spread.

This strawberry insect seems undescribed although its larval habits are fairly well known. The important consideration, at any rate, is established that the culture of the strawberry presents no menace to the grower of stone fruits, since the damage under discussion to the two plants has no connection.

NATURAL PARASITES.

That the larvæ of the peach twig-borer are attacked by parasites during the hibernating period has already been alluded to, and in fact, of the material received from Mr. Ehrhorn, nearly all had been destroyed by a minute predaceous mite, *Pediculoides ventricosus* (fig. 5). In most instances nothing remained of the larvæ except the empty heads.

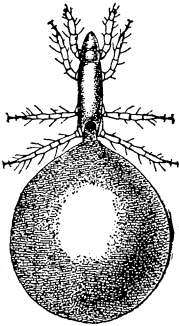


FIG. 5. — *Pediculoides ventricosus* — much enlarged (original).

Two minute hymenoptera, or four-winged fly parasites, have also been reared from the larvæ. The first of these was obtained by Professor Comstock, who in his studies of the peach twig-borer reared a parasite from it which he did not name, but which was later described by Dr. L. O. Howard as *Copidosoma variegatum*. The second fly parasite of *Anarsia* was obtained from the material in tree crotches submitted by Mr. Ehrhorn, and proves to be *Oxymorpha livida* Ashmead, a wide-spread species quite variable in point of size.

Of these parasites, in California the greatest benefit is derived from the mite, which, as we have already stated, frequently causes the death of from 75 to 95 per cent of the young larvæ.

REMEDIES AND PREVENTIVES.

The common method of procedure against this insect, and the one hitherto generally suggested, is to clip off and burn the withering infested tips in the spring as soon as the injury is noted. The forego-

ing life history emphasizes the fact that it is necessary to do this very promptly, for the larvæ remain in these situations a very short time, and early in May will have abandoned their burrows in the young shoots to transform, often elsewhere, although sometimes pupating in the withered leaves. The presence of dying terminals does not always indicate that a larva is necessarily present, since in many instances it will have wandered to some other point. With large orchards this step would be a very tedious one, and with trees of any size often impracticable.

WINTER TREATMENT WITH KEROSENE EMULSION.

The knowledge of the hibernating habits of this insect indicates a more effective method of control. This consists in spraying the trees during December or January, or any time after the foliage has fallen, with kerosene emulsion, resin wash, or some similar oily preparation which will penetrate the burrows and destroy the young larvæ. Mr. Ehrhorn found the kerosene treatment very satisfactory, as practiced in California in the winter of 1897-98, the little excremental pellets of the larvæ absorbing the oily mixture and leading it directly to the insect in its hibernating cell. For California Mr. Ehrhorn recommends that the application of the mixture should be begun in December.

Kerosene emulsion has one advantage over other oily preparations, such as the resin wash, in that it is more penetrating and will be more certain of reaching the larvæ.

Where the emulsion is to be prepared by hand it is better to make it in rather small quantities at a time in order to secure a perfect combination of oil and soap. The proportions usually taken are as follows: Kerosene, 2 gallons; whale-oil soap, half a pound; water, 1 gallon.

The soap, first finely divided, is dissolved in the water by boiling and immediately added boiling hot, away from the fire, to the kerosene. The whole mixture is then agitated violently while hot by being pumped back upon itself with a force pump and direct discharge nozzle, throwing a strong stream, preferably one-eighth inch in diameter. After from three to five minutes' pumping the emulsion should be perfect, and the mixture will have increased from one-third to one-half in bulk and assumed the consistency of cream. Well made, the emulsion will keep indefinitely, and should be diluted only as wanted for use.

For the treatment of large orchards, requiring large quantities of the emulsion, it may be advisable to prepare it with the aid of a steam or gasoline engine and suitable large tanks, as has been very successfully and economically done in several instances, all the work of heating, churning, etc., being accomplished by this means. When thus made the following proportions may be suggested: Kerosene, 10 gallons; whale-oil soap, 2½ pounds; water, 5 gallons. As a winter wash the emulsion may be diluted with about six volumes of water, making for

the larger quantity about 100 gallons and the smaller about 20 gallons of spraying mixture.

When hard water is employed in the making of the emulsion or in diluting afterwards, it is necessary to use about 25 per cent more soap, or preferably the water may be broken with lye, or rain water may be used.

In the use of kerosene or other oily washes on plants, the application should be merely sufficient to wet the plant without causing the liquid to run down the trunk and collect about the crown; usually at this situation there is a cavity caused by the swaying of the plant in the wind, and the accumulation of the insecticide at this point may result in the death or injury of the plant. It is even advisable to mound up the trees before spraying or to see that the earth is firmly packed about the base. Care should also be taken in refilling the tank to see that no free oil is allowed to accumulate in the residue left at the bottom.

In line with the use of kerosene emulsion may be suggested the use of pure kerosene mechanically combined with water in the act of spraying, as is now effected by a style of pump specially made for the purpose. A 20 to 25 per cent solution of the kerosene can be used without danger to the plant in its dormant condition, but it is necessary to watch the apparatus employed for this work very carefully to see that the proportion of oil to the water does not change, and on the whole it is much safer and more satisfactory to use the kerosene emulsion, the strength of which may be known definitely in advance and is not subject to variation.

SPRING OR FALL TREATMENT WITH ARSENICALS.

The possibility of destroying the larvæ of the peach twig-borer by spraying the plants with arsenicals, either in the fall or spring, has also been suggested, but such treatment demands the greatest caution on account of the extreme sensitiveness of the foliage of the trees ordinarily attacked by this insect to scalding when sprayed with these poisons.

The fall treatment is directed against the last brood of larvæ, and to be effective the poison should reach the parts of the plant where the eggs are most apt to be placed, presumably the crotches of the branches. Many of the larvæ might thus be poisoned while eating through the bark preliminary to the construction of their winter retreats. To effect anything of value by this course the poison must be applied early—that is, before the eggs are deposited—and the feasibility of the treatment will depend somewhat on the condition of the trees and the damage that might result from scalding of the foliage in late summer.

As a spring treatment, the arsenical spray should be applied to the trees at the moment the leaf-buds begin unfolding, so that the first meal taken by the over-wintered larvæ will be a poisonous one. The difficulty

with this method is that already given—namely, the extreme sensitiveness of the foliage of the peach and allied fruits to damage by scalding with arsenical sprays—and if this method is followed the poison should not be used in much greater amount than 1 pound of the arsenical to 400 gallons of water, previously mixing the poison up with an equal weight of lime in a small amount of water.

The experience in California with the arsenicals, as reported by Mr. Ehrhorn, has not been satisfactory. It has been found very difficult in actual practice to use them without danger to the plants. The winter treatment with kerosene emulsion, first described, is therefore especially and strongly advised.

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